DOCUMENT RESUME

ED 351 392 TM 019 231

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TITLE Conceptual Developments in Schema Theory.
PUB DATE 25 Sep 92
NOTE 30p.
PUB TYPE Information Analyses (070) -- Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Cognitive Psychology; *Concept Formation; Definitions; *Learning Theories; Models; *Networks; Prior Learning; Research Methodology; *Schemata (Cognition); Schematic Studies
IDENTIFIERS Dual Coding Hypothesis; *Schema Theory

ABSTRACT

The conceptual development of schema theory, the way an individual organizes knowledge, is discussed, reviewing a range of perspectives regarding schema. Schema has been defined as the interfacing of incoming information with prior knowledge, clustered in networks. These networks comprise a superordinate concept and supporting information. The information covers a wide perspective including defining features, characteristics, associations, functions, and propositions. These organizing methods allow schema to form networks with one another. Schema can be interwoven, subsumed, or enveloped by other schema. In this paper, several schema definitions are reviewed, and alternatives are presented. Applications of schema theory are illustrated, and current trends in schema research are reviewed, including the use of propositional analysis, mental models, and alternatives such as the theory of dual coding. The importance of schema theory in the development of cognitive science is discussed. One table summarizes 10 schema theories. (SLD)

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CONCEPTUAL DEVELOPMENTS IN SCHEMA THEORY

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Running head: CONCEPTUAL DEVELOPMENTS IN SCHEMA THEORY

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ABSTRACT

The purpose of this article is to consider the conceptual development of schema theory, the way in which an individual organizes knowledge. Its focus is on addressing comprehension through the interfacing of incoming information with prior, background knowledge found in clusters or networks comprised of a superordinate concept and connecting subordinate information. There are three objectives in this essay. The first is to present a variety of schema definitions in order to understand the range of the theory. The second objective involves the application of schema through illustrations that demonstrate their operating principles. Third, current trends in schema research such as the use of propositional analysis, mental models, and alternatives including the theory of dual coding are presented in order to clarify the conditions under which schema are employed. This article concludes with a discussion of the importance of schema theory in the development of cognitive science.

Between 1980 and 1985 three landmark papers were published that called attention to the process one employs in order to construct meaning. These three conceptual papers (Rumelhart, 1980; Anderson, 1985; and Anderson and Pearson, 1984) concentrated on schema theory, involving the manner in which an individual organizes information. Since that time, schema theory has been an important aspect of educational research, particularly in the area of reading comprehension. As schema theory developed through subsequent studies, problems arose involving the definition and application of schema. One purpose of this paper is to present a variety of schema definitions in order to understand the range of schema theory. The second objective involves the application of schema through illustrations that demonstrate their range of operations. Third, current trends in schema research will be presented in order to propose alternatives to schema theory.

Definition of Schema Theory

In its broadest sense, schema theory (also known as schemata theory) is a theory of knowledge (Rumelhart, 1980). This theory involves the manner in which material is organized, encoded and retrieved from one's memory. The information that comprises a schema can take a variety of forms. It can include concepts, qualities of an object, or sequences of operations. As a result, schema are involved with interrelated networks of information that can act alone, or in conjunction with related schema. An example of interrelated networks acting alone is illustrated in the concept of a "dog." The features of a dog include its four legs, fur and nose. These features interrelate in order to construct the "dog" concept. Interrelated networks that act in conjunction with related schema are found in

the activity of driving a car. The features that comprise the schema of a car interrelate with the procedural schema or driving sequence. It is also possible for one schema to embed or originate from another as in the case of the mathematical branch of calculus originating in arithmetic.

According to Rumelhart (1980, pp. 40-41) schema represent knowledge rather than definitions. However, it is not clear how knowledge is represented in contrast to definitions. On the one hand, a definition can be comprised of features that result in the knowledge of an objective or concept. On the other hand, one's information depends on both the external objective world and the internal subjective world of one's mind. Therefore, schema can represent both knowledge and concepts. Further, Klatzky (1980, p. 50) clarifies this problem by identifying schema as "a set of rules for producing or describing a prototype." A description of a prototype such as a triangle includes its ideal features and therefore a definition of a triangle is created. This results in one's knowledge of the concept, triangle.

It is important to note that one's schema can contain more than a prototype. It also contains processes that allow it to interact with incoming information. For example, in the activity of reading with respect to reading comprehension, the reader uses schema to explain events and objects in the text. In this matching, the reader brings their background knowledge to the text in order to understand it. Therefore, according to Anderson (1985, p. 370) schema interact with incoming information to construct an "organized knowledge of the world." As a result, the reader constructs meaning and builds their knowledge base.

The implications of this point of view are far reaching. First, according to Anderson (1985) schema provide scaffolding that help to assimilate text material. For example, story

grammar, the setting, plot, goal, theme and ending of a story provides a structure on which text material can be categorized, connected and understood. Second, Anderson's (1985) notion of schema as ideational scaffolding is enhanced by his view that schema contain slots. These slots interface with supporting text information and the degree to which there is a match between the schema and text material corresponds to the ease the material can be processed in one's memory or learned. Further, as the match or goodness of fit increases between the reader's schema and the text, the reader will comprehend more of the text while allocating less attention to encoding, activation and retrieving the text information (Anderson, 1985). However it is important to note that the nature and purpose of the task demands and one's intrinsic motivation are important variables in processing information (Anderson and Pearson, 1984).

According to Herson, Kazdin and Bellack (1983), intrinsic motivation can direct schema activation. For example, if one is intrinsically motivated in a subject area such as history then he or she may be able to connect that schema to other areas such as economics, and literature. Such a mapping of one schema onto another facilitates understanding and serves as a framework for future information encoding, activation and retrieval. As a result, a person can experience personal growth, and increased knowledge, (Herson, Kazdin, & Bellack, 1983). One way in which motivation is enhanced is through active interactions between the reader and the text. This may occur as the reader makes inferences or predicts future events that he or she expects will happen in the text.

Inferencing occurs when the reader makes a prediction to bridge the gap between the text information and his other background schema. Inferencing involves hypotheses and the

adjustment of one's reasoning. There are four types of schema inferences; the first, involves drawing hypotheses and "conclusions based on a lack of knowledge" (Anderson & Pearson, 1984, p. 269). This relies on the logic of the event or text and its application to a situation that may or may not be analogous to the topic. The second type of influence involves instantiation, the representation of an abstraction in concrete form. For example, a text selection that discusses a familiar character from the story without revealing his or her name may result in having the reader attempt to determine the character who was intended to fill the void (Anderson & Pearson, 1984).

The "assigning [of] default values in the absence of any substantiation information in the text" is the third type of inference (Anderson & Pearson, 1984, p. 269). In this case, the author assumes that he or she has shared information with the reader. Often this knowledge is shared as common knowledge. An example of an inference by default is when the author describes a situation in which it is not necessary to give all the details as in the case of pounding a nail into a piece of wood. This example does not require the identification of the hammer, the tool used in this case, because it is inferred, shared knowledge.

The fourth type of inference involves selecting the correct schema to assist in comprehension. In the case of reading comprehension, the initial sentence of a selection may give important clues concerning which schema to apply for a greater understanding of the text. For example, the unified team at the 1992 Winter Olympics can serve as a cue to employ the schema of the former Soviet Union in order to recall the Unified Team's general geographic location, and its connection with the former Soviet Union. In this case, such an association facilitates the processing of the unified team schema.

Inferencing is valuable when one thinks of schema as knowledge frameworks on which content can be attached and connected. There are a number of ways in which such connections take place. The four types of inferences previously discussed (drawing hypotheses, instantiation, shared information and associative cueing) are channels through which new material is integrated into preexisting schema. The reason a reader uses inferencing is to make better sense of the external world while building his or her knowledge base. As a result, comprehension is enhanced and deeper processing takes place through inferential, schema activation.

Schema Structure

Just and Carpenter (1987) presented a structured schema theory through their computer simulation model called Reader. Their theory presented schema theory as a knowledge structure. This structure consists of a superordinate concept, idea or concrete object, and slots. The slots are arranged in hierarchial importance in order to describe the superordinate principle. For example, the model can take a superordinate concrete object such as "car", and order its properties by levels of importance. Such an ordering includes the car's name, goals, principles, physical properties, movements, model, use and example (Just & Carpenter, 1987, p. 255). The Reader model can also describe an abstract object such as "story." A schema such as a story grammar can be constructed to include a particular selection and its elements. For example, these schema slots include: setting, character,

episode, event, reaction, response, actions, consequence, sequence of events, and conclusion (Just and Carpenter, 1987). Thus we are left with a cluster or network of knowledge that facilitates comprehension.

According to Rumelhart (1980), schema are building blocks of cognition because they organize material in order to increase comprehension. Therefore, clustering is an important variable of comprehension. In particular, clustering allows for greater efficiency in processing information. This efficiency can be measured in terms of information retrieval or recall. "The basic finding is that subjects with a more developed schema for some body of knowledge show higher recall for materials related to that knowledge" (Brewer & Nakamura, 1984, pp. 48-49). It is important to note that two of three studies cited involved narratives, stories that are rich in related events or incidents (Brewer & Nakamura, 1984). The reason for this is two fold: first, stories that involve related events activate schema and enhance deep processing among related schema. Second, related events can be organized under specific categories and add comprehensive perspectives to schema.

The term category is often confused with concept. For example, the concept of "cat" serves as an ideal model for all cats. It illustrates what all cats are like, and serves as a prototype. In definition, a category is "the set of stimuli that are instances of a particular concept" (Bower & Clapper, 1991, p. 273). For example, a beagle, golden retriever, and chow are instances of the concept dog; therefore, they are dog categories. This schema illustrates a general concept that is represented and supported by subordinate instances of the concept.

In the dog schema, the categories satisfy three characteristics. First, there is coding experience; that is, the types of dogs that are applied to the prototype. Second, each category is believed to have qualities that match with the concept. Some of these qualities may not be seen e.g., internal anatomy, yet they are inferred as a characteristic of the concept. This characteristic is called an inductive inference. The third characteristic is similarity. That is, the similarity to the concept, as well as the distinctiveness between categories (Smith, 1990). This explanation of categories can be further elaborated with an understanding of the ways in which these networks of knowledge are organized.

There are a number of ways information may be interrelated or organized in order to construct a schema. The information may be interrelated through association as exemplified in the Teachable Language Comprehension (TLC) program (Ellis & Hunt, 1989). The TLC program organizes information into a hierarchy, such as the animal, bird, canary, ostrich schema (Ellis & Hunt, 1989, p. 143). The focus of this organizing principle is that it takes less time to determine that a canary is a bird than an ostrich is a bird (Ellis & Hunt, 1989, p. 142). It appears that a canary has more characteristics of a bird prototype, and that the canary properties are activated more frequently than those of the ostrich (Ellis & Hunt, 1989, p. 90). This implies that the bird characteristics of an ostrich are lower in the schema hierarchy than those of the canary.

In order to explain this semantic distance effect, a schema theory of spreading activation was developed (Ellis & Hunt, 1989, p. 146). According to this theory, the further removed an activation node is from its source, the weaker its signals. For example, an ostrich is further removed from the prototype of a bird than that of a robin, therefore, it will

take longer to identify an ostrich as part of the bird schema than it will take to identify a robin as a member of the bird schema. Weak signals increase reaction times (Ellis & Hunt, 1989, p. 146). However, this is not always a consistent finding. For example, it will take less time to react to the sentence, "a cow is an animal" than "a cow is a mammal" (Ellis & Hunt, 1989, p. 146). Thus, an alternate approach to schema construction is advocated to supplement and elaborate on the inadequacies of the theory of spreading activation.

Another approach to schema theory involves defining features and characteristic features (Ellis & Hunt, 1989, p. 147). The better the fit between the defining and characteristic features, the quicker one responds and ascertains the object (Ellis & Hunt, 1989, p. 149). There are some interesting questions to consider in this approach to schema construction. First, can a prototype be changed by altering its features? For example, the prototype of a bird includes feathers, wings, and activities such as flight; however, a penguin is a bird and it does not fly. Perhaps such an apprehension depends on the context in which the schema is activated (Ellis & Hunt, 1989, p. 150). That is to say, specific aspects of the schema will be activated and matched under certain conditions.

Schema can also be represented by propositional networks. According to this theory, information is placed in small units called propositions. Each proposition forms true or false units in which nodes are connected. An example of a proposition is the following: "Chris drives a Corvette." A Corvette is a fast car, therefore, "Chris drives a fast car." There are some important factors to consider in this theory. First, are some propositions stronger than others, given their identical distance from the central concept?" If this is the case, then there is support for a theory of background knowledge that would assist in the activation of

particular propositions. This in turn ushers in questions of intention and motivation. For example, if one is reading with the intention of finding typographical errors, then a specific schema set will predominate the reading process (Goodman, 1884). Comprehension will be a secondary consideration to the typographical schema. Therefore, schema can be arranged by more than one method, and these methods can interact as one's background knowledge interfaces with incoming information.

According to McNamara, Miller and Bransford (1991), prior knowledge is represented by schema. This background knowledge is especially useful in reading comprehension. Experience that is drawn upon motivates students to read with interest (Perin, 1988). As the students read, new information is assimilated into existing schema. The new material becomes relevant to the students' background knowledge. Therefore, the material is more easily encoded in one's knowledge base.

Encoding is a primary stage in the comprehension process. It is "the process by which new incoming information is related to and transformed by preexisting knowledge structures" (Schacter, 1989, p. 689). This information may be subsumed into categories and clustered around a concept. As a result, a schema is constructed and encoded. The frequency of its activation adds to its use and deepens the level in which the schema is encoded (Schacter, 1989). This deeper, semantic level also increases the strength of the schema, and facilitates its access. However, this does not mean that schema are frozen, unalterable constructs. The very nature of encoding incoming information into a superordinate, subsuming schema results in alterable, dynamic schema. Simon and Kaplan (1989, p. 10) sum up the dynamic, changeable aspects of schema in the following: "Schema

can form other parts of schema and, conversely, schema contain schema. They may be propositionlike, picturelike, or both."

Bransford (1985) approaches schema construction through the use of elaboration, stating that "new facts can seem arbitrary unless they are precisely elaborate in a way that clarifies their significance or relevance" (Bransford, 1985, p. 395). Therefore, schema can be altered and enhanced. Such elaboration must be precise and meaningful to the individual in order to facilitate encoding. The significance of the information can also be presented from a particular perspective or context that is meaningful to the reader, student, or individual (Bransford, 1985; Kardash, Royer, & Greene, 1988). The result of such schema elaboration is a construct that is accessible and retrievable.

Schema theory is characterized by its efficient access to encoded information through retrieval. According to Kardash, Royer, and Greene (1988, p. 325) "it is clear that schema exerts an influence on the recall of text information." This is supported by their free-recall experiment involving the retrieval of text information from a specific perspective or schema. Their results showed that more information was recalled by the experimental group (those given a perspective or schema) than that recalled by the control group, (those instructed to carefully read the story) (Kardash, Royer, & Greene, 1988). In other words, schema related information was recalled better than unconnected information. This is supported by Brewer and Nakamura (1984, p. 640) who found that schema retrieval is significant in linguistic materials e.g., texts read from specific viewpoints, and nonlinguistic materials such as goal directed actions.

In summary, there are several approaches to the construction and functioning of schema. Just and Carpenter (1987) developed schema as a hierarchical model consisting of a superordinate concept and hierarchically supporting slots of information. Problems with this approach involved the criteria for determining the hierarchical placement of the slots that supports the superordinate concept. These difficulties are exemplified in the theory of spreading activation (Ellis & Hunt, 1989). According to this theory, the further a node is from its source, the longer it takes to associate it with a particular schema. The problem with this approach involves, exceptions to schema access and retrieval. According to Ellis and Hunt, (1989, p. 146) it takes less time to identify a cow as an animal than a cow as a mammal; although the node "mammal" is semantically closer to "cow" than the more distant node, "animal" in this propositional example. As a result, additional supplemental approaches involving defining characteristics and features are also employed to determine schema. These alternate forms depend on the context or task demands in which a particular schema activated, structured or retrieved. Further, these models allow for schema elaboration thus enhancing the ways in which information is organized and processed. Therefore, these models serve as situational applicators of schema.

Theoretical Problems

Schema theory is a very broad concept that has been employed to explain the construction of comprehension and the importance of background knowledge. As a result, it has reached into several areas of cognition. A few of these regions include encoding, retrieval, clustering, and organization. In fact, evidence for schema and its effects have been

studied throughout the cognitive spectrum. As a result, many questions have been raised regarding schema theory. These challenges range from definitional, conceptual aspects of schema theory, to the empirical evidence found in landmark studies. Therefore, attention is now turned to the questions raised by schema theory.

A predominant problem involving an inquiry into schema theory is the lack of consensus among its theorists. Samuels and Eisenberg (1981) describe it as an organized group of concepts that represent general knowledge. What constitutes general knowledge? Rumelhart (1980) is more ethereal in viewing schema as a theory of knowledge. His definition is very close to epistemology. However, his elaboration of schema as clusters or networks of information surrounding a concept serves to construct a particular theory of knowledge.

Simon and Kaplan (1989) view schema as highly flexible constructs from propositional to picturelike, or both. They can be inset with one another and form additional schema. This focus is similar to the study of productions in cognition (Anderson, 1990). Productions are created when there is a match between declarative memory elements. Then this information is chunked together, and rules for its activation e.g., problem solving, are constructed, stored and retrieved from the procedural memory. This production is responsive to additional information and the changing environment, therefore the production, like schema are dynamic and can change.

Klatzky (1980, p.50) considers schema in terms of sets of rules that describe or produce a prototype. For example, the concept of circle is a prototype, as well as that of a car. Each concept is an archetype that has particular qualities, features, and functions that

describe it. However, is a prototype comprised of all its features or functions, or do individuals exclude some of them? It is possible that the prototype of a car has changed over time due to technological advances. Therefore, if a prototype is an archetype or ideal, can it change?

Just and Carpenter (1987) present a concrete model, composed of a superordinate concept and a set of slots that serve as hierarchically subordinate aspects of the main idea. However, it is not clear whether schema can have two or more categories that interact such as attributes and functions. That is, how is the hierarchy of the information cluster determined? Perhaps a type of bird is known more for its physical appearance than its ability to fly. Is a robin more of a bird than a hummingbird? This question is directly related to the hierarchical construct of the slots that describes the superordinate concept. Retrieval time in terms of concept identification may not be a sufficient measure of such an identification. It may be a measure of individual differences.

As a result, there is a lack of clarity in the structural application of schema. Ellis and Hunt (1989) discuss schema theory in terms of semantic memory. They present associative networks, features, and propositions as semantic memory theories, interwoven with schema. The goal of this orchestration is to enhance pattern recognition through the activation semantic memory (Ellis & Hunt, 1989). As a result, in reading, new text information is integrated into networks of prior, background information.

The uniting of new information integrated into networks of background knowledge involves top-down activation, also known as conceptual processing (Rumelhart, 1980).

Philosophically, it is deduction in the sense that a general schema is activated followed by subschema utilization. For example, as the schema of car is activated, subschema that also serve as part of the general schema are engaged. The subschema that also form the categories of the car concept include doors, tires, motor and chassis. Therefore, the background information serves to provide a framework for incoming information resulting in greater comprehension. The opposite approach is bottom-up activation in which the parts define the whole. This data driven approach, also known as induction in the classic sense, can be explained with the following illustration: one view of reading comprehension is that meaning is constructed from decoding letters to words, and on to sentences, paragraphs and larger structures of the story. Throughout this process, meaning is developed from an atomistic view to an inclusive picture of comprehension.

However, these approaches may be used in conjunction with one another. This is the interactive model of comprehension. For example, in a reading selection, features of print are activated, producing letters or words. This is a data driven approach. These words activate higher level concepts, that in turn facilitate expectations and predictions while reading or speaking. These predictions influence the meaning of the text as well as expectations in print. The entire process may include all of these approaches under particular conditions. In addition, such a view can involve an interactive method in which different sources of information are used at the same time or in parallel (Klatzky, 1980). In this case, information comprehension is the result of a variety of schema procedures implemented at the same time.

The flexibility in schema structure is often interpreted as an inconsistency in schema theory. One problem involves the content of a schema. Just and Carpenter (1987) include a

superordinate concept and slots that describe the concept in their schema structure. However, it is not clear whether the superordinate concept must be a conceptual ideal or prototype. According to Ellis and Hunt (1989), a schema can be a representation of a propositional network in which small units of information are presented and their relationships with one another form a schematic representation of the network (Ellis & Hunt, 1989, pp.151-152). Further, if the network includes relations among propositions then the manner in which the schema is supported is more complex than schema involving single concepts such as dog or cat. In this case the schema is expanded and several schema overlap and envelope one another. These theoretical problems carry over to empirical studies resulting in alternative explanations and options to schema theory.

The theoretical problems involving schema theory are founded on the ramifications of their definitional difficulties expressed in the following table. For example, Samuels and Eisenberg (1981) propose that schema are organized groups of concepts representing general knowledge. However, an area that requires further investigation is: what constitutes general knowledge? It can be thought of as basic concepts such as "triangle" or actions such as "running." However, these terms often take place in a context and in the time continuum. As a result, there is debate over whether schema are prototypical abstractions or whether they can be altered over time. Another point of contestation involves retrieving items from schema. The problem in this case involves the hierarchical arrangement of subordinate information (slots) that identifies a schema. It has been shown that sometimes information is retrieved faster in a schema if it is less centrally located than other slots of information. One example that comes to mind is the case of "a cow is an animal" opposed to "a cow is a

mammal." (Ellis & Hart, 1989, p. 146). The rationale for this anomaly includes the nature of the task, and the rate at which this node is activated. If the node is activated often, then deeper processing and habit can develop, perhaps predominating over a more centrally located node or slot.

Further elaboration is needed to explain the relation between schema and situational texts. According to McNamara, Miller and Bransford, (1991), schema are replaced by mental models in the context of text related situations; however, these mental models may be dependent upon schema, represented as general knowledge comprised of concepts and supporting information. This dependence may take place in order to allow the reader to comprehend the propositions expressed in a text. As a result, schema and mental nodels are used in the reading process to yield comprehension.

What are the boundaries of schema? Rumelhart, (1980) theorizes that schema can absorb subschema and create larger schema. An example of this is the grand schema of a car that is comprised of subschema such as motor, wheels,, chassis, etc.. In fact, these images can be intermixed with propositions and text to create new connections such as "the Volvo is in the garage." Is this a new schema or a proposition, or a new schema and proposition? These points illustrate some problems in the research or schema theory resulting in alternate approaches to the topic as expressed in the next section.

Table 1

Summary of Selected Schema Theories

AUTHOR	MAJOR POINTS OF SCHEMA	AREAS REQUIRING FURTHER INVESTIGATION
Anderson (1985)	Ideational scaffolding consisting of a concept and slots of supporting information	What is the relationship of the slots to the task demands? Are the slots equally important to one another?
Anderson & Pearson (1984)	Knowledge stored in memory, structured to represent relations among its component parts	Why is there such a variety of relations among the component parts of different schema?
Ellis & Hunt (1989)	Relations among networks of propositions	How are schema delimited?
Just & Carpenter (1987)	Superordinate concept supported by slots of subordinate information	What criteria constitutes the hierarchical arrangement of subordinate information?
Klatsky (1980)	Rules that produce or describe a prototype	Are all features required to form prototype; can the prototype change over time?
McNamara, Miller & Bransford (1991)	General structure of propositions, sources and nodes	Why are schema excluded from textual and situational representation?
Rumelhart (1980)	Clusters of information	Why are there inconsistencies in spreading activation or the semantic distance effect?
Sadoski, Pavio & Goetz (1991)	Lack of consistent definition	How do the nonverbal(images) and verbal language processing systems interconnect to provide holistic and situational constructs in one's memory?
Samuels & Eisenberg (1981)	Organized group of concepts representing general knowledge	What constitutes general knowledge?
Simon & Kaplan (1989)	Flexible constructs from propositions and picture images	Are propositions and images parallel processes or do they intermix?

Empirical Problems

According to Sadoski, Paivio and Goetz (1991) schema theory has gained legitimacy through several landmark cases; however, there are alternative interpretations that question the validity of the studies. For example, Bransford and Franks (1971) conducted studies in which subjects were presented with compound sentences containing four propositions. Then the subjects were given a recognition test that included the previous sentences, sentences with altered propositions, and new sentences similar or dissimilar to the original sentences. The results indicated that the subjects recognized the former sentences with the propositions, and that the more propositions a sentence had that matched the original, the more likely it was to be recognized. Therefore, the subjects recognized altered sentences that contained parallel propositions, and did not recognize sentences that were propositionally inconsistent. The study found that the "subjects acquired an abstracted and integrated representation of the meaning of sentences, but not a accumulation of individual sentence or word meanings, as the integrated representation encompassed more information than any of the original sentences contained" (Sadoski, Paivio, & Goetz, 1991, pp. 468-469). This means that integration occurred for sentences that were semantically similar and propositionally consistent. However, it was also found that integration occurred with nonsense syllables, a nonsemantic medium by using the same procedure (Alba & Hasher, 1983). Therefore, the results of the Bransford and Franks (1971) study provide a constrained situation, process and purpose in which semantic integration takes place. These constraints are also found in ambiguous texts and bizarre reading selections. For example, the interpretation of an ambiguous text is based on one's background knowledge. However, this is not the sole criteria that accounts for

comprehension. Other factors such as the environment in which the text is read, cultural differences, and individual distinctions also account for the organization of information in text comprehension (Sadoski, Paivio, & Goetz, 1991). Additional factors such as one's personal perspective and the importance and coherence of the material need to be examined when considering how one assimilates new information with prior, background knowledge (Sadoski, Paivio, & Goetz, 1991). These factors are closely associated with one's motivation and metacognitive skills in addition to an overarching schema theory. The question here is whether schema theory oversteps its boundaries by subsuming these factors.

In contrast, these factors help to delineate schema theory. For example, issues such as cultural differences and environmental factors such as reading location and social surroundings contribute to the organization of information, recall, integration, and comprehension. An additional variable in the construction of meaning is the purpose one has for reading a selection. This involves the nature of the reading task e.g., literature or a textbook. Also, the types of questions one must answer play a role in schema theory. That is, reading for pleasure may evoke different schema than reading to answer questions at the end of a chapter. As a result, optional perspectives need to be considered for schema theory and comprehension. Such an approach may include alternatives to schema, depending on one's purpose for reading a selection. These new approaches involving the organization of information are presented in current research models.

Current Research and Trends

The connection between incoming information and its appropriate schema is critical to

reading comprehension; however, it does not explain the understanding of novel situations and objects. Therefore, a view of "comprehension as a process of building and maintaining a model of situations and events described in a text" is required (McNamara, Miller & Bransford, 1991, p.493). These situational text representations are called mental models. A mental model has a "structure that corresponds to the structure of the situation that it represents" (Johnston-Laird, 1989, p.488). This structure is comprised of tokens, represented in the following: In place of the sentence, "all students are readers," for any x if x is a student then x is a reader. Pictorially, it is represented as students-readers. Therefore, mental models are images that do not contain the detail of verbatim sentences.

One problem with this notion is that all language can be represented by propositional representations, and these structures preserve the text structure (Laird-Johnson, 1989). Therefore, the need for mental models is questionable. However, the use of mental models is highly situational as in the case of establishing instructions, and in providing support for better recall of the events described by a text (McNamara, Miller & Bransford, 1991). Therefore, the nature of the task and its situation limit the use of mental models. For example, implicit memory knowledge cannot be represented as explicit propositions, images or tokens of mental models. Thus, mental models are incomplete, and strongly dependent on specific situations in which they can be employed.

Another alternative to schema theory involves verbal and nonverbal representation systems called dual coding (Sadoski, Paivio, & Goetz, 1991). This theory organized verbal stimuli in terms of logogens representing phonemes, graphemes, morphemes, words, larger units, sequential and syntactical processing (Sadoski, Paivio, & Goetz, 1991, p.473).

Nonverbal stimuli are organized in terms of images such as a natural object, visual-spatial items, and natural groupings of objects that are processed in a parallel fashion (Sadoski, Paivio, & Goetz, 1991, p.473). In addition, these systems are interconnected and are connected to the neurological system (Sadoski, Paivio, & Goetz, 1991). Therefore, information is processed through this dual coding theory. As a result, the information from this perspective goes beyond that in the sentence; it serves to provide holistic, situational representations. For example, the phrase "once upon a time" evokes experiential associations and images such as fairy tale, prince, and happy endings (Sadoski, Paivio, & Goetz, 1991, p. 473). Therefore, according to the theory of dual coding, the need for a propositional network for a situational representation is diminished by a holistic construct.

Summary and Conclusion

Throughout this essay a wide range of perspectives regarding schema has been explored. It has been defined as the interfacing of incoming information with prior knowledge, clustered in networks. These networks are comprised of a superordinate concept and supporting information. This information covers a wide perspective including defining features, characteristics, association, functions and propositions. These organizing methods allow schema to form networks with one another. Schema can be interwoven, subsumed or enveloped by other schema. the recurrence of its activation deepens the level that the schema is encoded and allows for faster, more efficient access.

It is important to note that individual and cultural differences play an important part in the way in which one encodes information. For example, critical readers predict, question

and infer information that often activate schema structures. In addition, such active participation allows a reader to become familiar with patterns of schema in particular areas or domains. Therefore, over time, the individual has learned schema for investigative and solution procedures within particular domains, and a set of generalized schema for problem solving and inquiry across domains of knowledge. This is a case of tactical expertise due to practice and familiarity with patterns (Anderson, 1990). For example, as one becomes familiar with the game of chess, he or she increasingly recognizes certain patterns or displays on the game board. The more familiar one is with the variety of chess piece patterns, the more expertise and proficiency he or she has at countering a move or attacking it, in order to win the game. As a result, schema theory becomes active in problem solving, and in the architecture of cognition (Simon & Kaplan, 1989).

The major problem limiting schema theory is its definitional and developmental ambiguity. How general must a cluster or network be in order to qualify as a schema? For example, there is a restaurant schema; yet this schema can be interpreted as a mental model if a particular restaurant is presented in the text one is reading. Indeed, both schema and mental models are images that do not focus on intricate detail as in the case of verbatim structures. In addition, it is not clear whether all schema must contain a prototypical concept. The definition of a prototype is an ideal. However, can an ideal change? The prototype of a triangle is stable and unchanging; however, that of a car may change due to technological advances. Thus, schema theory is beset with another ambiguity.

These ambiguities result in alternatives to schema and directions for future research. This movement has diverged into a number of areas. The notions of mental models and

propositional networks are two alternatives that can be implemented in very specific, novel situations. Propositional networks maintain sequential, verbatim structures while mental models use tokens and images that do not require the structure found in propositional networks. The organization of information has also called attention to expertise in the sense that pattern familiarity and practice contribute to efficient information organization and problem solving. Perhaps in the future schema theory will be approached from a more neurobiological point of view? The recent theory of dual coding has emerged to organize information into verbal and nonverbal categories that can also connect at reference points (Sadoski, Paivio, & Goetz, 1991). Nonverbal information is organized as pictures or images, while verbal information received elaborations (Sadoski, Paivio, & Goetz, 1991). Information becomes semantically processed through the two codes. For example, the use of a phrase in language can evoke images and feelings as well as logogens representing graphemes, words, sentence fragments and larger units of linguistic processing. As a result, schema are not required in the reconstruction of information. Mental modelling, propositional analysis and dual coding are a few directions to which schema related research has travelled, progressed and developed. The future of schema theory may include these topics as well as neurobiological connections involving regions of the human brain and the cells that comprise the areas.

Throughout this essay a number of schema definitions have been developed and alternatives to schema have been presented; each notion and option builds on preceding research, examining schema theory from a new perspective, contributing to its development. Therefore, schema theory is in the process of progressing from an epistemological philosophy

to a science; perhaps ultimately into a neuroscience. Pictorially, this process unveils a glimpse at the concept of schema theory. Its broad philosophical base and its construction through scientific research creates a vision of a pyramid as research delineates and shapes its rising perimeter.

References

Alba, J.W., & Hasher, L. (1983). Is memory schematic? Psychological Bulletin, 93, 203-231.

Anderson, J.R. (1990). Cognitive psychology and its implications. New York: W.H. Freeman & Co.

Anderson, R.C. (1985). Role of the reader's schema in comprehension, learning and memory. In H. Singer and R. Ruddell (Eds.), Theoretical models and processing of reading (3rd ed.) (pp. 372-384). International Reading Association, Newark, DE: Erlbaum.

Anderson, R.C. & Pearson, P.D. (1984). A schema theoretic view of basic processes in reading comprehension. In P.D. Pearson (Ed.), Handbook of reading research. New York: Longman.

Bower, G., & Clapper, J. (1989). Experimental methods in cognitive science. In M.J. Posner (Ed.), Foundations of cognitive science (pp. 245-300). Cambridge, MA: MIT Press.

Bransford, J. (1985). Schema activation and schema acquisition: Comments on Richard C. Anderson's remarks. In H. Singer and R. Ruddell (Eds.), Theoretical models and processing of reading (3rd ed.), (pp. 385-397). International Reading Association, Newark, DE: Erlbaum.

Bransford, J.D. & Franks, J.J. (1971). The abstraction of linguistic ideas. Cognitive Science, 2, 331-350.

Brewer, W. & Nakamura, G. (1984). The nature and functions of schemas. (Technical Report No. 325) Bolt, Beranek and Newman, Inc., Cambridge, MA; Illinois University, Urbana. Center for the Study of Reading. (Eric Document Reproduction Service No. ED 248 491).

Brown, S., Conover, J., Flores, L. & Goodman, K. (1991). Clustering and recall: Do high clusterers recall more than low clusterers because of clustering? Journal of Experimental Psychology: Learning Memory and Cognition, 17, (4), 710-721.

Ellis, H., & Hunt, R. (1989). Fundamentals of human memory and cognition. Dubuque: Brown.

Goodman, K.S. (1984). Unity in reading. In A.C. Purves and O. Niles (Eds.), Becoming readers in a complex society (pp. 79-114). Chicago: University of Chicago Press.

Herson, M., Kazdin, A., & Bellack, A. (Eds.). (1983). The clinical psychology handbook. New York: Pergamon.

Just, M.A., & Carpenter, P.A. (1987). The psychology of reading and language comprehension. Boston: Allyn & Bacon.

Kardash, C.A., Royer, J.M., & Greene, B.A. (1988). Effects of schemata on both encoding and retrieval of information from prose. Journal of Educational Psychology,80, 324-329.

Klatzky, R. (1980). Human memory: Structures and processes. San Francisco: Freeman.

Laird-Johnson, P.N. (1989). Mental models. In M.J. Posner (Ed.), Foundations of cognitive science (pp. 469-500). Cambridge, MA: MIT Press.

McNamara, T., Miller, D., & Bransford, J. (1991). Mental models and reading comprehension. In R. Barr, M. Kamil, P. Mosenthal and P.D. Pearson (Eds.), Handbook of reading research: Volume 2. White Plains, N.Y.: Longman.

Newell, A., Rosenbloom, P., & Laird, J. (1989). Symbolic architectures for cognition. In M.J. Posner (Ed.), Foundations of cognitive science (pp. 93-132). Cambridge, MA: MIT Press.

Perin, D. (1988). Schema activation, cooperation and adult literacy instruction. Journal of Reading, 54, 54-62.

Rumelhart, D.E. (1989). The architecture of mind: A connectionist approach. In M.J. Posner (Ed.), Foundations of cognitive science (pp. 133-160). Cambridge, MA: MIT Press.

Rumelhart, D.E. (1980). Schemata: The building blocks of cogniton. In R.J. Spiro, B.C. Bruce, & W.F. Brewer (Eds.), Theoretical issues in reading comprehension (pp. 33-58). Hillsdale, N.J.: Erlbaum.

Sadoski, M., Paivio, A., & Goetz, E. (1991). A critique of schema theory in reading and a dual coding alternative. Reading Research Quarterly, 26, (4), 463-484.

Shacter, D. (1989). Memory. In M.J. Posner (Ed.), Foundations of cognitive science (pp. 683-726). Cambridge, MA: MIT Press.

Simon, H., & Kaplan, C. (1989). In M.J. Posner (Ed.), Foundations of cognitive science (pp. 1-48). Cambridge, MA: MIT Press.